

Lecture 2

CSE 331

Feb 3, 2021

Enroll on Piazza

The screenshot displays the Piazza Q&A interface for CSE 331. The top navigation bar includes 'LIVE Q&A', 'Drafts', and a list of homework assignments (hw1-hw8, video_project, exam, logistics, other, midterm, final, quizzes). The main content area is titled 'Class at a Glance' and provides a summary of the course's status:

- no unread posts**
- no unanswered questions**
- 1 unresolved followups**
- license status**: contribution-supported
- 34** total posts
- 157** total contributions
- 47** instructors' responses
- 8** students' responses
- 1 min** avg. response time

Below this summary is a 'Student Enrollment' section showing a progress bar for 229 enrolled students out of 300 (estimated). There are also links to download the Piazza app from the App Store and Google Play.

The 'Share Your Class' section includes a message from professors and a demo link: https://piazza.com/demo_login?nid=kjul6x8mazc3ia&auth=044fab. A note indicates that opening this link in the same browser will log you out as erdem@buffalo.edu.

The '2021 Product Updates' section lists several key updates:

- LTI 1.3 & SAML Single Sign-On (SSO)**: We will be upgrading to the latest IMS integration protocol, LTI version 1.3. This protocol gives control back to course administrators with the increased ability to regulate Piazza usage through the university's learning management system (LMS). In addition to LTI 1.3, we are also implementing full support for SAML Single Sign-On (SSO) to further secure access to university content. SSO gives the university greater control over who can create and access course content by redirecting students and instructors signing into Piazza Q&A to the university's login portal. With LTI 1.3 and SAML SSO, Piazza will provide expanded administrative controls including enrollment management, roster synchronization with the university LMS, the ability to capture usage metrics, and grade book integration. We expect these updates to go live by Fall 2021.
- Piazza Lite Enhancements**: We are adding expanded features to Piazza Lite, Piazza's accessible Q&A product for students with specific learning needs. Over the next several months, we will be bringing features found on the main Q&A platform to include support for polls, upvoting, and advanced filters. These capabilities will go live in March. We will also add a new support page that highlights which features are supported and not supported in Piazza Lite.
- Accessibility of the main Piazza Q&A App in 2022**: Accessibility continues to be top of mind for many universities and its learners. At Piazza, our long-term commitment is to dismantle the barriers to accessibility as

The left sidebar shows a list of pinned posts, including 'Office hours in the first week', 'Welcome to CSE 331!', and 'Efficiency implications of Helper functi...'. The 'THIS WEEK' section includes posts about homework grades and video project assignments.

<https://piazza.com/buffalo/spring2021/cse331>

Read the syllabus and hw policy CAREFULLY!


Syllabus Quiz


Options

[View handin history](#)

[View writeup](#)

[Download handout](#)

 Due: February 28th 2021, 3:47 pm

 Last day to handin: February 28th 2021, 5:47 pm

No graded material will be handed back till you pass the syllabus quiz!
195 (out of 271) already completed!

Academic Integrity

Question 1: Sharing my answers to this syllabus quiz with other 331 students

- Is OK if I do it to help out a friend
- It does not matter since there is no grade attached with it
- Is an academic integrity violation and should not be done
- Is an academic integrity violation but I can take the chance

Question 2: Penalty for academic violation in CSE 331 is an automatic

- Warning and a chance to make-up
- A zero in the assignment AND a letter grade reduction (for first violation across all CSE courses) and an F in the course (for 2nd violation across all CSE courses)
- A zero in the corresponding assignment and nothing else
- Expulsion from UB

You can submit the following now

Assignments

Homework 0

Q1 part (a) [Number of perfect matchings]

Q1 part (b)

Q3 (Structured Matrix Vector Multiplication)

Quizzes

Syllabus Quiz

You all should be on Autolab now
(let me know if not!)

HWs

[50 pts] Q1 (easier) is a proof-based question; two parts

[25 pts] Q2 (harder) is a proof-based question; two parts

[25 pts] Q3 is a programming question; autograded

HWs due by 8:00pm on Fridays

(assigned a week before)

NO LATE SUBMISSIONS!!!

Support page

CSE 331 Care Package

Starting Fall 2019, CSE 331 will be assuming more background material was covered in CSE 250 (and CSE 191). In particular, starting Spring 2020, CSE 331 will assume a non-trivial coverage of proofs and other related material in CSE 191 and CSE 250. While we make this transition, this page collect materials that were covered in previous incarnations of CSE 331 but will no longer be covered going forward (this also includes material that are not covered in CSE 191/250). We hope that this page is helpful if you took the older version of CSE 191/250 or you took the equivalent courses in another school.

The Topics

Below we collect the topics that we will no longer cover in CSE 331 (but were covered as late as Fall 17 or Fall 18):

- [Asymptotic Notation](#)
- [Trees](#)
- [Topological Ordering](#)
- [Minimizing Maximum Lateness](#)

C++ vs Java/Python

Use Java/Python if you are just as comfortable with as C++

Use a VM with g++ installed for Ubuntu

We recommend that you install a VM that runs `g++` on Ubuntu. In particular, we recommend that you use [Jaric Zola's](#) VM system that he created for his CSE 250 course. If you have questions on Jaric's setup, please do **NOT** contact him: email cse-331-staff@buffalo.edu instead.

If you still prefer using your own system, we would still recommend that you test your code in the VM system above before submitting to Autolab.

Allowed Sources

Allowed sources

You can **ONLY** use the following sources for reference once you start working on the homework problems:

1. the Kleinberg-Tardos textbook,

Other textbooks are not allowed

While you can use other textbooks (e.g. those listed in the [syllabus](#)) to better understand the lecture material, you **cannot** use them once you start working on the homeworks.

2. any material linked from this webpage or the CSE 331 piazza page (including any discussion in the Q&A section),

One-click rule

When using webpages that are allowed as sources, you **cannot** click on link on that source. (Otherwise within a constant number of clicks one can reach any webpage one wants.)

3. specific *mathematical* result from a previous course,
4. anything discussed in the lectures, recitations and/or office hours and
5. any notes that you might have taken during class or recitation.

Everything else is not allowed


Note that the above list covers all the allowed sources and **everything else is not allowed**. In particular, *YOU ARE NOT SUPPOSED TO SEARCH FOR SOLUTIONS ON THE*

... even for programming Q

- All discussions and posts on [piazza](#) .

Basic programming references


C++ Sources

- [cppreference.com](#)  (and all pages within the website).

Java Sources

- [Oracle Java Documentation](#)  (and all pages within the website).

Python Sources

- [Python 3.5.2 documentation](#)  (and all pages within the website).

Asymptotic Analysis

- [Big-O cheat sheet](#) .

Wikipedia Pages

Below are some approved Wikipedia pages (in addition to those that are already linked to in other pages in the [CSE 331 Fall 2018 web page](#)).

- [Gale Shapley algorithm](#) .
- [DFS](#) .
- [Dijkstra's Algorithm](#) .
- [Prim's algorithm](#) .

Why do proofs?

Makes you think logically about problems and solutions

From an engineer who works on Google Maps:

Proving that the algorithm I am implementing is correct helps me identify corner cases

Why should we do proofs?

We will focus a lot on proofs in CSE 331. In this document I will motivate why doing proofs is good even though you might not do proofs for a living. While doing this, we will also go through examples of how to write algorithm ideas and details as well as proof ideas and details (which you will need to write in your homework solutions).

Some reasons to do proofs

In this section, I will lay out some reasons why I think it is beneficial for you guys to do proofs. The first two are probably more along the lines of "if you do proofs for a living" situation. The rest of the reasons should be valid for all of you. I will try and make the reasons as concrete as possible: in the next section, we will consider algorithms for the specific problem of generating all permutations (recall that we [previously](#) had punted on designing an algorithm for this problem).

Sometimes you might not have a choice

One of the easiest way to verify an algorithm idea you have is to code up the algorithm and then test it on some (say random) inputs. However, sometimes this might not be a choice. E.g. if you work on [Quantum Computing](#), then you do not have a quantum computer to run your quantum code on! So currently pretty much the only choice you have is to *prove* that your algorithm is indeed correct. For example, one of the crowning achievements of quantum computing is [Shor's algorithm](#) to computes the factors of large numbers efficiently on a quantum computer (that recall does not exist yet!). (You might also want to read [Scott Aaronson's high level description of Shor's algorithm](#).) The reason why [factoring large numbers](#) is important is that if one can solve this problem efficiently then one can break the [RSA cryptosystem](#). RSA is used everywhere (e.g. when you use your credit card online, RSA is used to make the transaction secure), so this is a big deal.

<https://cse.buffalo.edu/~erdem/cse331/support/proofs/index.html>

A more subtle incorrect “proof”

Brad Pitt has a beard



waleg.com

Every goat has a beard



animaldiversity.org

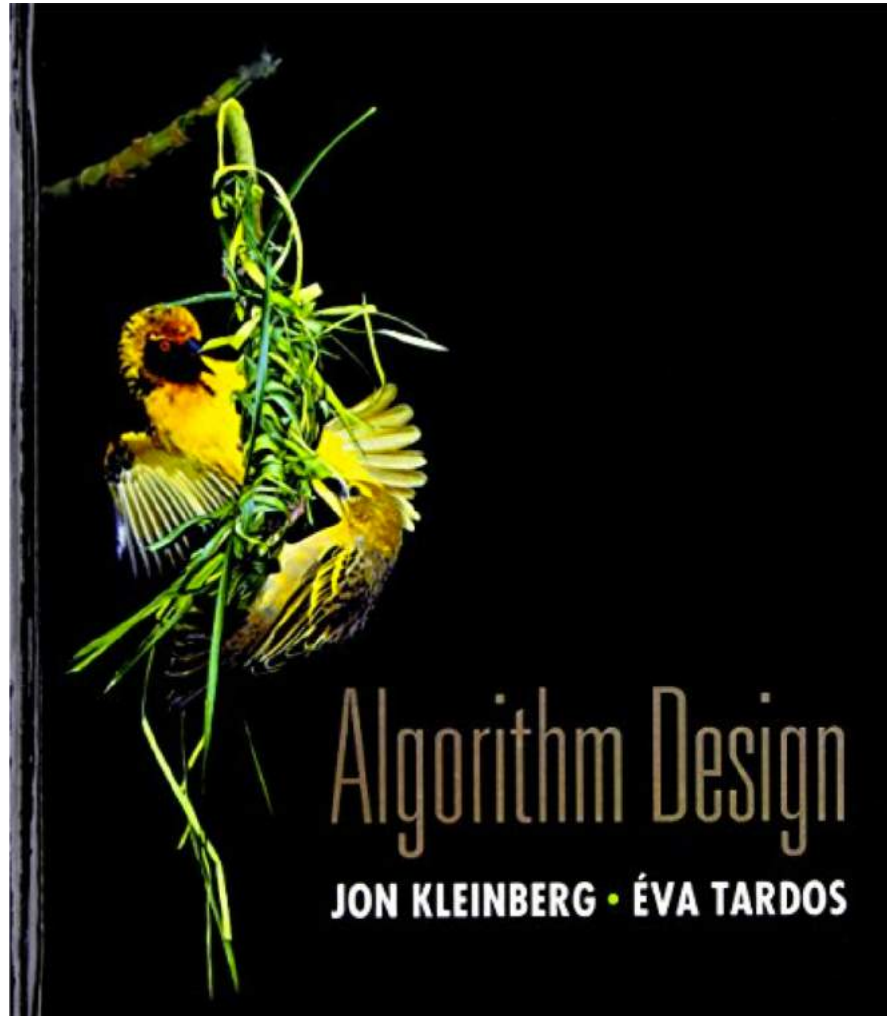
Hence, Brad Pitt is a goat.

More chances to recover

Lowest two HW scores will be dropped

If you do better on the final exam than the mid-term exam then only final exam score will count

Follow the Textbook



CSE 331 Support Page

This page contains certain webpages that students taking CSE 331 might find useful.

The material is roughly divided into two parts: one on (primarily mathematical) background material and one of common mistakes that students generally make.

Disclaimer

Please note that this material is intended as a support material. It is not meant as a replacement for actually having taken background courses like CSE 116, 191 or 250 nor is this meant to be exhaustive. I'll try my best to make these as comprehensive as possible but that might take some time.

Background material

CSE 331 will need a fair bit of math: most of which you must have seen earlier. However, if you have not used those material for a bit then you might be a bit rusty. The pages linked below are some notes that I wrote up that might help you refresh the material that you might have seen in CSE 116, 191 or 250. Also some of the pages are meant to motivate why we do some things a certain way in CSE 331. Finally sometimes (but not often!) we will use material that might not have been covered in previous courses and we did not have much time to cover in class: these pages will fill in those gaps.

Common Mistakes

Here we collect some common mistakes that students make in CSE 331 material (and sometimes more than once). The hope is to list these common pitfalls so that you can avoid them!

Other Resources

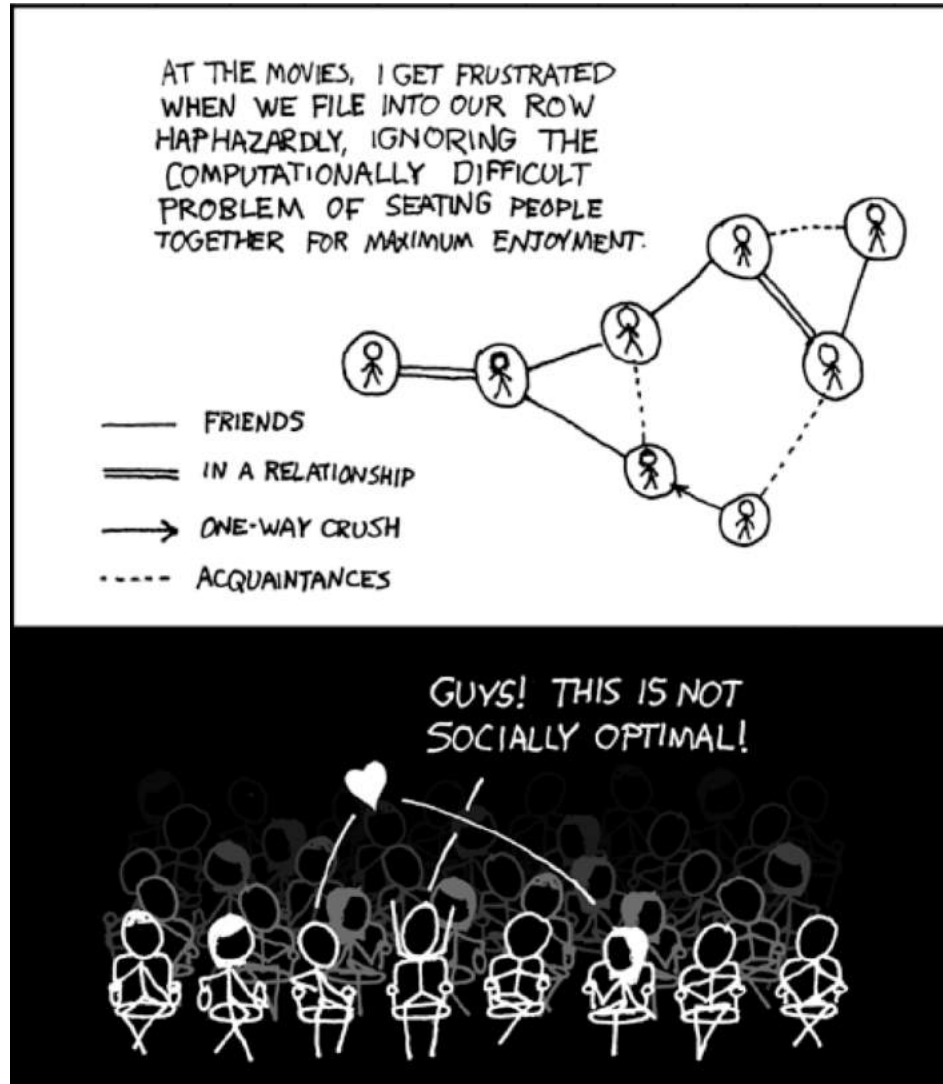
Below we collect other 331 related material that do not neatly fall into the two left category:

- [Visualizing Algorithms.](#)
- [Algorithms via Examples.](#)

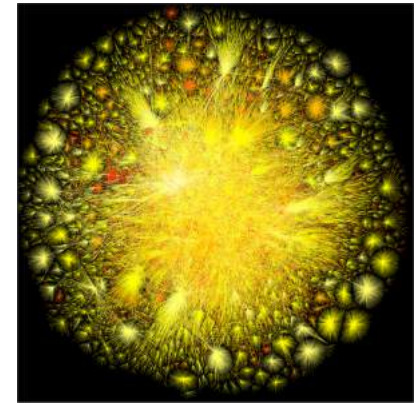
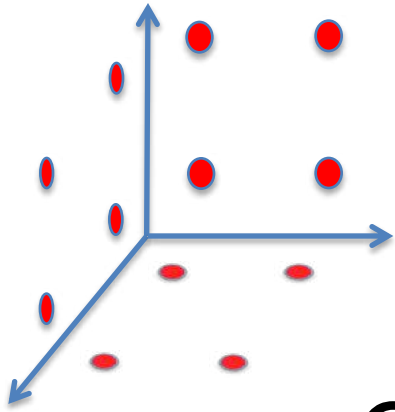
<https://cse.buffalo.edu/~erdem/cse331/support/index.html>

Questions/Comments?

This course: how to solve problems!



Why should I care ?



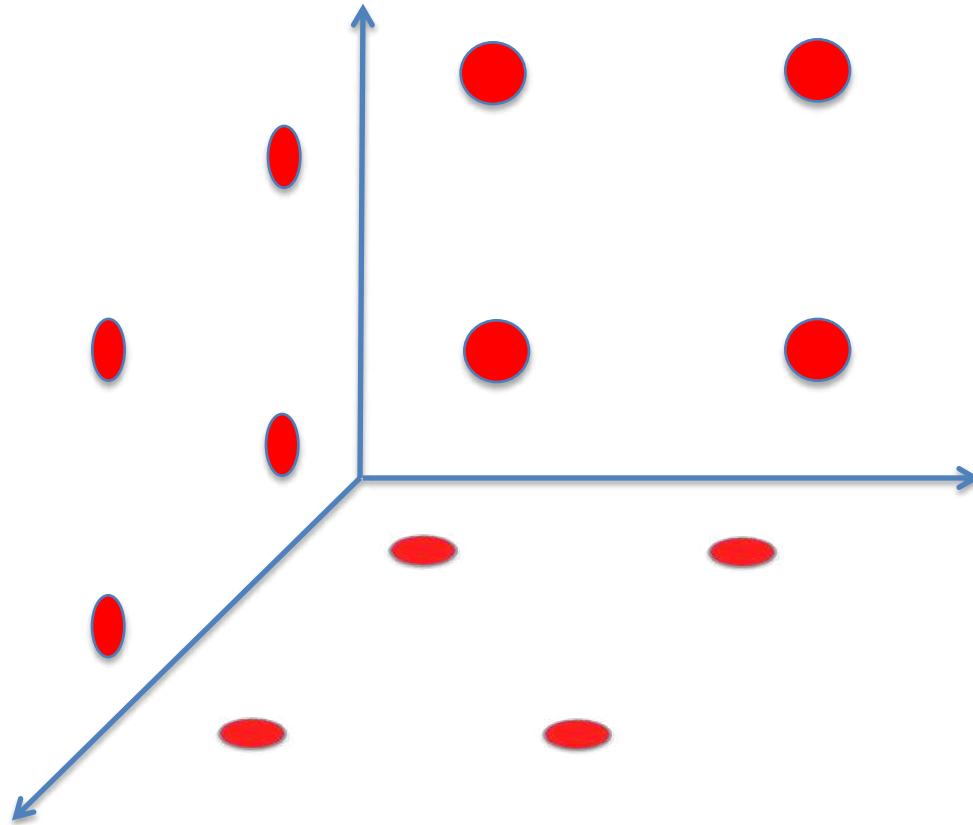
Combining Shadows to Understanding the network



LogicBlox

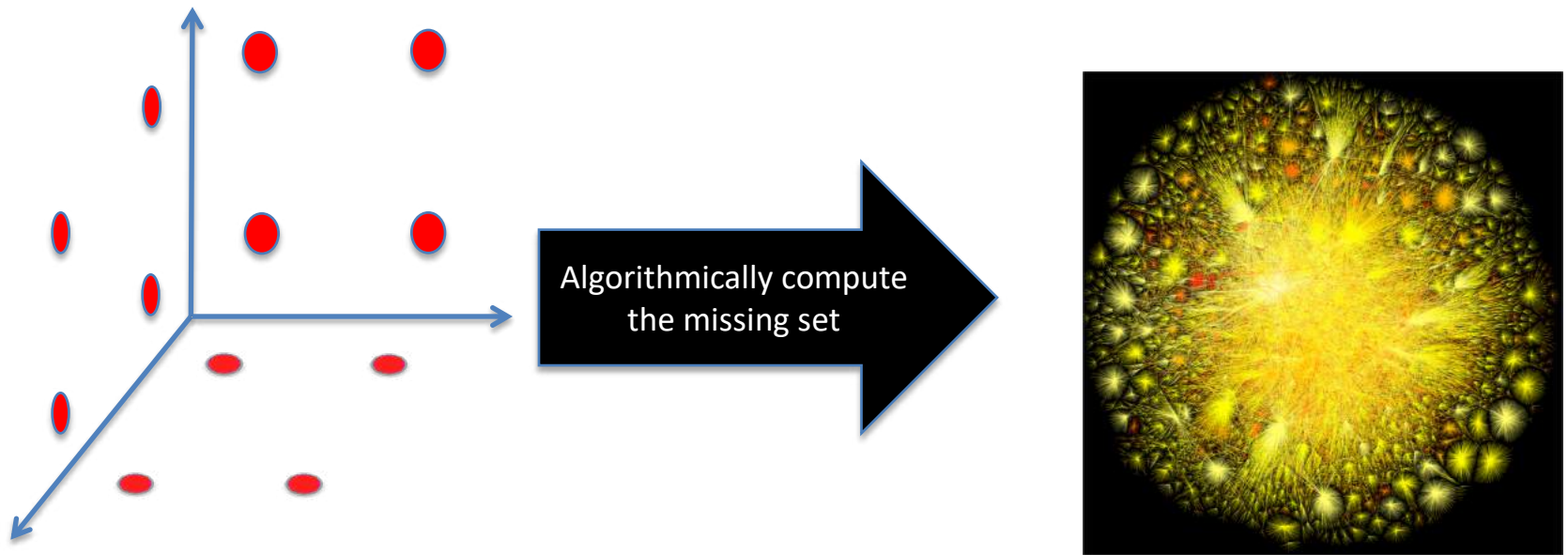
Stanford
University

The key technical problem



Given the three projections, what is the largest size of the original set of points?

Conquering Shadows to Conquering the Internet



The proof is in the performance



EMPTYHEADED

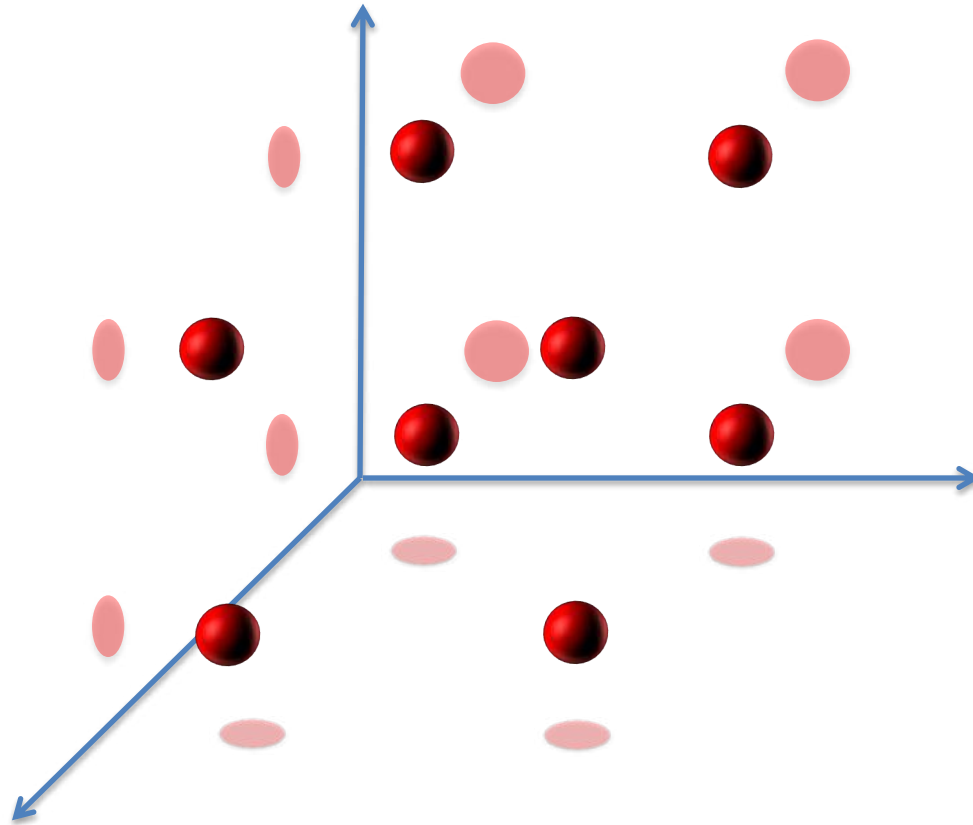


10x faster

A large, thick green arrow pointing from the left towards the right, indicating a comparison or transition.

Better algorithm with little hacking will beat a worse algorithm with tons of hacking

The key technical problem



Highly trivial: $4^3 = 64$

Still trivial: $4^2 = 16$

Correct answer: $4^{1.5} = 8$

From someone who got a Google job

“You can let your algorithms class know that the phone interviews are essentially like **a difficult algorithms test.**”

Lots of data structures, specifying the algorithm, analyzing the run time and space requirements... And all on the phone and **you're supposed to talk through your thought process.**”

Coding jobs will be done by AI



stacksort

In a [recent xkcd's](#) alt text, Randall Munroe suggested **stacksort**, a sort that searches StackOverflow for sorting functions and runs them until it returns the correct answer. So, I made it. If you like running arbitrary code in your browser, try it out.

Like (or hate) it? Comment on HackerNews

stackoverflow_sort(

Try a list of numbers, a string, a list of words or json.

);

Sort

var output =

Output from the function.

;

output console

Coding jobs will be done by AI

MIT News

ON CAMPUS AND AROUND THE WORLD

Browse

or

Search



 FULL SCREEN

Researchers have developed a flexible way of combining deep learning and symbolic reasoning to teach computers to write short computer programs. Here, Armando Solar-Lezama (left), a professor at CSAIL, speaks with graduate student Maxwell Nye.

Photo: Kim Martineau

Toward artificial intelligence that learns to write code

Researchers combine deep learning and symbolic reasoning for a more flexible way

So am I doomed?

There will still be room for high level *algorithmic* thinking!



A screenshot of the European Association for Theoretical Computer Science (EATCS) website. The header features a logo on the left, a circular logo with a hand pointing to a globe, and the text "European Association for Theoretical Computer Science" in blue. Below the header is a navigation menu with links for HOME, ABOUT, SEARCH, CURRENT, and ARCHIVES. The main content area shows a breadcrumb trail: "Home > No 125: June 2018 > Lamport". The title of the article is "If You're Not Writing a Program, Don't Use a Programming Language" in blue, followed by the author information: "Leslie Lamport, Distributed Computing & Education Column by Juraj Hromkovic, Stefan Schmid".

*Today, programming is generally equated with coding. It's hard to convince students who want to write code that they should learn to think mathematically, above the code level, about what they're doing. Perhaps the following observation will give them pause. **It's quite likely that during their lifetime, machine learning will completely change the nature of programming. The programming languages they are now using will seem as quaint as Cobol, and the coding skills they are learning will be of little use. But mathematics will remain the queen of science, and the ability to think mathematically will always be useful.***

Why care about algorithms?

← from Virginia Beach, Virginia to Buffalo, New York

9 h 39 min (582 miles)
via I-95 N
Fastest route, the usual traffic
⚠️ This route has tolls.

Virginia Beach
Virginia

- Take Arctic Ave and 22nd St to I-264 W/Norfolk Virginia Beach Expy/Virginia Beach Expy
4 min (0.8 mi)
- Take I-64 W, I-295 N, I-95 N, I-270 N, ... and I-80 W to PA-153 N in Penfield. Take exit 111 from I-80 W
6 h 49 min (432 mi)
- Get on US-219 N in Ashford from PA-153 N
2 h 21 min (113 mi)
- Continue on US-219 N. Drive to Church St in Buffalo. Take exit 7 from I-190 N
35 min (36.1 mi)
- Take Delaware Ave to your destination
2 min (0.4 mi)

Buffalo
New York

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause

Map details: Satellite view, Live traffic, Fast/Slow indicators.

Driving directions

Why care about algorithms?

Buffalo, NY, United States (B) Cape Town, South Africa (C) 02/02/2020 02/23/2020 Search

Nearby airports Nearby airports

1 Traveler, All Airlines, Economy / Coach Show options

Select your departure to Cape Town Sun, Feb 2

Prices are roundtrip per person, include all taxes and fees, but do not include baggage fees.

Sort & Filter Clear Show flexible dates

Sort by Price (Lowest)

Save up to \$420* when you book your Flight and Hotel together. Shop Flight + Hotel

Stops	From:	Cheapest flight		
<input type="checkbox"/> 1 Stop (4)	\$1,544	4:45pm - 6:00pm +1	18h 15m (1 stop)	4 left at \$1,543.72
<input type="checkbox"/> 2+ Stops (69)	\$1,549	United	BUF - 2h 5m in EWR - CPT	roundtrip
		Excellent Flight (8.6/10)	United 4306 operated by Expressjet Airlines DBA ...	Earn \$15.44
		Details & baggage fees		
Airlines included	From:			
<input type="checkbox"/> Delta (37)	\$1,891	2:30pm - 6:00pm +1	20h 30m (1 stop)	4 left at \$1,543.72
<input type="checkbox"/> United (17)	\$1,544	United	BUF - 4h 20m in EWR - CPT	roundtrip
<input type="checkbox"/> Air France (13)	\$2,403	Excellent Flight (8.6/10)	United 5012 operated by CommutAir DBA United ...	Earn \$15.44
<input type="checkbox"/> South African Airways (11)	\$1,891	Details & baggage fees		
<input type="checkbox"/> KLM (10)	\$3,440	2:45pm - 6:00pm +1	20h 15m (2 stops)	4 left at \$1,548.22
<input type="checkbox"/> British Airways (5)	\$4,794	United	BUF - IAD - EWR - CPT	roundtrip
<input type="checkbox"/> American Airlines (4)	\$5,318	Excellent Flight (8.5/10)	United 3908 operated by Air Wisconsin DBA Unite...	Earn \$15.48
		Details & baggage fees		

Booking cheapest air tickets

Why care about algorithms?



Google Search

I'm Feeling Lucky



WELCOME TO THE GATHERING PLACE

Computer Networks and ISDN Systems 30 (1998) 107-117

COMPUTER
NETWORKS
and
ISDN SYSTEMS

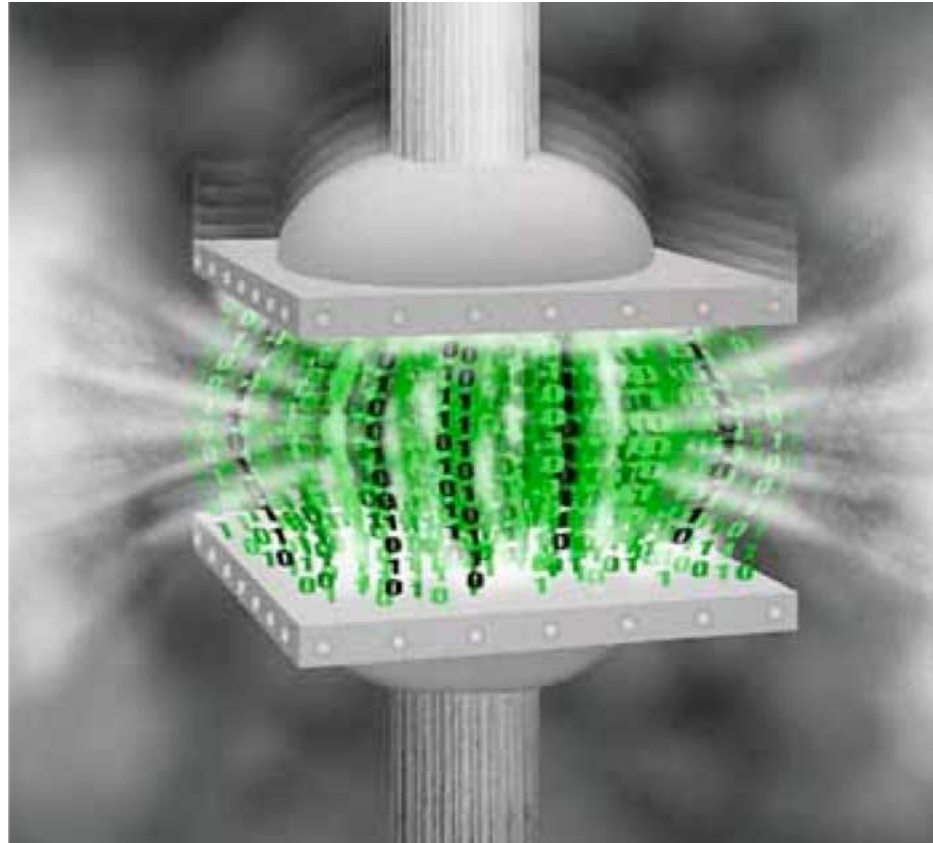
The anatomy of a large-scale hypertextual Web search engine ¹

Sergey Brin ², Lawrence Page ^{*,2}

Computer Science Department, Stanford University, Stanford, CA 94305, USA

Google searches

Why care about algorithms?



<http://www.di.ens.fr/~cherniaev/teaching.html>

Data compression

(And I could) go on...

Find out for yourself

Video project: Video on ethical impacts of algorithm. Groups of size = 3

CSE 331 Video Project

Spring 2021

Details and motivations for the video project.

Motivation

CSE 331 is primarily concerned with the technical aspects of algorithms: how to design them and then how to analyze their correctness and runtime. However, algorithms are pervasive in our world and is common place in many aspects of society. The main aim of the video project is to have you explore in some depth social implications of algorithms.

Just to give two examples for such implications:

- Algorithms are pervasive in financial transactions and these algorithms have consequences beyond just trading:



Questions/Comments?